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Gametophytic and Sporophytic Responses of *Pteris* spp. to Arsenic

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Abstract.—Few plant species have demonstrated the ability to hyperaccumulate heavy metals from contaminated soil. Recently, *Pteris vittata* L. has been identified as a hyperaccumulator of arsenic. Because gametophytic development is an essential stage in the fern life cycle, impacts of heavy metal hyperaccumulation on gametophytic and sporophytic tissue must be investigated if successional bioremediation efforts are to be implemented successfully. Our research showed that sporophytes as well as gametophytes of *P. vittata* are capable of As uptake and accumulation. Increased As ($\leq$2500 ppm) did not inhibit spore germination, and deleterious effects on gametophyte morphology were observed only after extended time periods on media with extremely high As concentrations ($\geq$600 ppm). Six other *Pteris* species varied in ability to germinate on As-containing media. Sporophytes of *P. vittata* showed no adverse effects when exposed to the highest soil As levels (1650 ppm); in fact, root proliferation was observed in areas of increased As concentration (250 ppm). Foliar application of an arsenical herbicide (calcium acid methanearsonate) to sporophytes resulted in decreased chlorophyll and carotenoid concentrations. Phosphate additions inhibited As uptake by sporophytes, indicating As uptake involves the phosphate transport system.

Arsenic (As), a group 15 metalloid known for its toxicity, commonly occurs in earth's crustal rocks and soil but is minimally present in and often highly detrimental to biological organisms (Cullen and Reimer, 1989). While As concentrations in the environment are often low and non-problematic ($<$10 mg kg^{-1} in soil and $<$1 mg kg^{-1} in plants), anthropogenic activities, such as mining, industry, and agriculture as well as natural geophysical processes elevate As levels (Adriano, 1986; Meharg *et al.*, 1994; Brandstetter *et al.*, 2000; Schmöger *et al.*, 2000). Present techniques for decontamination of soils are costly and highly destructive to ecosystems by often requiring the physical removal of soil for chemical treatment or by rendering the substrate static (Lombi *et al.*, 2000; McGrath *et al.*, 2001).

Phytoremediation, using plants to ameliorate contaminated water or soil, is a much less disruptive procedure (McGrath, 1998; Salt *et al.*, 1998). One such method of phytoremediation, phytoextraction, involves sequestration of contaminants in the harvestable portions of a plant for later removal and subsequent disposal (Salt *et al.*, 1998; McGrath *et al.*, 2001). This method is